OUTCOMES OF PATIENTS WITH ACUTE KIDNEY INJURY AT MOI TEACHING AND REFERRAL HOSPITAL, ELDORET

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A THESIS SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF MEDICINE (INTERNAL MEDICINE), SCHOOL OF MEDICINE, MOI UNIVERSITY

DECLARATION

STUDENT'S DECLARATION

This thesis is my original work and has not been presented for an award of any degree in any other university.

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DEDICATION

I dedicate this work to my family for their tremendous encouragement and motivation throughout this study.

I am truly grateful.

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ABBREVIATIONS

ADQI	Acute Dialysis Quality Initiative
AKI	Acute Kidney Injury
AKIN	Acute Kidney Injury Network
AMPATH	Academic Model Providing Access to Healthcare
CKD	Chronic Kidney Disease
eGFR	Estimated Glomerular Filtration Rate
ESRD	End Stage Renal Disease
GFR	Glomerular Filtration Rate
ICU	Intensive Care Unit
ISN	International Society of Nephrology
KDIGO	Kidney Disease: Improving Global Outcomes
MTRH	Moi Teaching and Referral Hospital
NSAIDs	Non- Steroidal Anti-inflammatory Drugs
RIFLE	Risk, Injury, Failure, Loss and End-stage renal disease
RRT	Renal Replacement Therapy
USA	United States of America
USD	United States Dollar
WBC	White Blood Cell count

DEFINITION OF TERMS

Acute Kidney Injury

Was defined as the presence of any one of the following (KDIGO 2012):

- Increase in serum creatinine value by ≥26.5 μmol/l within 48 hours in the absence of a prior history of, or clinical features to suggest the presence of chronic kidney disease.
- A 150% (1.5-fold) increase in serum creatinine from baseline which is known or presumed to have occurred within the prior 7 days.

All-Cause Mortality

Death from any cause within 90 days from diagnosis of acute kidney injury.

Baseline Creatinine

The last known serum creatinine of the patient within 3 months before falling ill or in case that was not available, the first serum creatinine after admission was presumed to be the baseline creatinine. Where the first serum creatinine was deranged, in absence of prior history of chronic kidney disease, a normal baseline was presumed as recommended by KDIGO.

Complete Recovery

Serum creatinine corresponding to estimated glomerular filtration rate of 75ml/min/1.73m^2 within the period of study follow up.

End Stage Renal Disease

Persistent need for renal replacement therapy after 90 days.

Need for Renal Replacement Therapy

Was defined as any patient requiring dialysis within the hospital admission period as indicated by any of the conventional indications as determined by the managing physicians.

Partial Recovery

Improvement in the KDIGO acute kidney injury stage without fulfilling the criteria for complete recovery and without the need for renal replacement therapy.

Severity of Acute Kidney Injury

Was defined according to the KDIGO 2012 stages as follows:

Stage 1: Serum creatinine 1.5-1.9 times above baseline, or a rise in serum creatinine of 26.5µmol/l or more.

Stage 2: Serum creatinine 2-2.9 times above baseline.

Stage 3: Serum creatinine 3 times of the baseline, or increase in creatinine above 353.6µmol/l, or initiation of renal replacement therapy.

Risk Factor Categorization

Patients were clinically categorized into 3 categories namely: Pre renal, intrinsic/renal and post renal/obstructive following clinical assessment from history, physical exam and file evaluation. Though, patients were categorized into 3 distinct categories, it was possible that a patient could have two or more risk factors from the same category or from the other two categories and hence they were not mutually exclusive.

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ABSTRACT

Background: Acute kidney injury (AKI) is a global problem and a significant cause of morbidity and mortality. The incidence of AKI based on data from high income countries is about 1 in 5 admissions; 1 in 4 of those that develop AKI die from its complications. Developing countries assume the same incidence and outcome of AKI as the developed countries.

Objective: To describe the clinical presentation and determine the 90-day outcomes of patients with AKI as seen at Moi Teaching and Referral Hospital (MTRH).

Methods: A prospective cohort study was done on all consenting patients above 18 years with AKI in the MTRH medical, surgical and gynecology inpatient wards. This was from January to July 2018 and a total of 103 patients were recruited. Demographic data and the clinical characteristics were collected using a structured interviewer-administered questionnaire. Participants were then followed up for 90 days and assessed for need for dialysis, recovery, progress to chronic kidney disease (CKD) and mortality. Categorical variables such as gender, severity of AKI, need for dialysis and mortality were summarized using frequencies and the corresponding percentages. Continuous variables such as age and creatinine level were summarized using mean and the corresponding standard deviation or median and the corresponding inter quartile range (IQR).

Results: The mean age of the participants was 46.7 (SD 18.3) years. Majority were males at 61 (60%). Most of the patients were in stage 3 disease at 65 (63%). The mean creatinine at admission and at 90 days were 817.2 and 169 µmol/l respectively. Main comorbidities were hypertension at 31 (36.9%) and human immunodeficiency virus (HIV) at 28 (33.3%). The causes of AKI were multifactorial, the most common being pre-renal with vomiting at 50 (48.5%) and sepsis at 31 (30%). Need for dialysis was at 31 (30%) with a mean time to dialysis of 3.7 days and an average of 3.8 sessions (IQR 1- 7). Median length of hospitalization was 9.5 days (IQR 7-17.5). Fifteen participants were lost to follow up. Complete recovery was observed in 29 (52.7%) of the participants while 8 (14.5%) had partial recovery and 18 (32.7%) progressed to end stage renal disease (ESRD). We had a 35 (34%) all-cause mortality with most deaths occurring in stage 3 disease.

Conclusion: Gastrointestinal tract losses and sepsis were the commonest risk factors for AKI with hypertension and HIV being the main comorbidities among these patients. Most patients presenting at MTRH with AKI had severe disease. Majority of the patients recovered their renal functions but a significant number had partial recovery of renal functions. Mortality was high.

Recommendation: Patients with diarrhea and vomiting as well as sepsis need to be identified and managed early before stage 3 AKI. Factors associated with late discovery of AKI need to be investigated and mitigated. Emphasis on a management plan for the patients with partial recovery that require long term follow up to prevent progression to ESRD.

CHAPTER ONE: INTRODUCTION

1.1 Background

Acute kidney injury, formerly known as acute renal failure, is a syndrome characterized by rapid (hours to days) loss of the kidney's excretory function that leads to accumulation of end products of nitrogen metabolism as measured by blood urea nitrogen (BUN) and serum creatinine levels. It is the clinical manifestation of several disorders that affect the kidney acutely (Bellomo et al., 2004). Acute kidney injury (AKI) is a clinical diagnosis guided by standard criteria based on changes in serum creatinine, urine output or both (Kellum, 2015).

Until recently, there was no consensus on the diagnostic criteria or clinical definition of AKI, resulting in multiple different definitions (Susantitaphong et al., 2013). This made it difficult to compare between scholarly works and to generalize findings on epidemiologic studies of AKI to patient populations, prompting several classification systems to be developed in order to streamline research and clinical practice with respect to AKI (Roy et al., 2013).

In 2004, the Acute Dialysis Quality Initiative (ADQI) group developed a system for diagnosis and classification of a broad range of acute impairment of kidney, the Risk, Injury, Failure, Loss, End stage (RIFLE) criteria (Uchino et al., 2006). Three severity grades were defined on the basis of the changes in serum creatinine or urine output, where the worst of each criterion was used and two outcomes, loss and end stage renal disease (ESRD), were defined by the duration of loss of kidney function (Hoste et al., 2006). The shortcoming of the RIFLE criteria was its application in patients with preexisting chronic kidney disease (CKD). In patients with elevated baseline serum creatinine, the proportional changes required by RIFLE to diagnose acute kidney disease seemed excessive (Kellum, 2015).

In September 2007, The Acute Kidney Injury Network (AKIN) modified the RIFLE criteria so that it would also classify AKI when only an absolute increase in serum creatinine (26.5µmol/l or greater) was recorded in a short period of time (48 hours or less) (Mehta et al., 2007). Soon after, Joaniddis et al conducted a cohort analysis to compare the two criteria. The study found out that RIFLE criteria failed to detect 9% of cases detected by AKIN criteria whereas AKIN criteria missed 26.9% of cases detected by RIFLE criteria. These results provided strong rationale for use of both RIFLE and AKIN criteria to identify patients with AKI (Joannidis et al., 2009).

RIFLE and AKIN were then unified by the 2012 Kidney Disease: Improving Global Outcomes (KDIGO) criteria which define and stage AKI according to changes in serum creatinine levels and urine output (Kellum & Lameire, 2013). They defined AKI as the presence of either an increase in serum creatinine by ≥26.5µmol/l within 48 hours or increase in serum creatinine to ≥1.5 times baseline which is known or presumed to have occurred within the prior 7 days or urine volume <0.5ml/kg/h for 6 hours.

	Serum creatinine			Urine output
	RIFLE	AKIN	KDIGO	
Definition	SCr increase ≧50% within 7 days	SCr increase ≧50% or ≧0.3 mg/dL within 48 h	SCr increase ≧0.3 mg/dL within 48 h or ≧50% within 7 days	UO < 0.5 mL/kg/h for 6 h
Staging	RIFLE	AKIN	KDIGO	
RIFLE-Risk AKIN stage 1 KDIGO stage 1	SCr increase ≧50% or GFR decrease >25%	SCr increase ≧50% or ≧0.3 mg/dL	SCr increase ≧0.3 mg/dL within 48 h or ≧50% within 7 days	UO < 0.5 mL/kg/h for 6 h
RIFLE-Injury AKIN stage 2 RIFLE stage 2	SCr increase ≧100% or GFR decrease >50%	SCr increase ≧100%	SCr increase ≧100%	UO < 0.5 mL/kg/h for 12 h
RIFLE-Failure AKIN stage 3 KDIGO stage 3	SCr increase ≧200% or GFR decrease >75% or SCr ≧ 4 mg/dL (with an acute rise ≧0.5 mg/dL)	SCr increase ≧200% or SCr ≧ 4 mg/dL (with an acute rise ≧0.5 mg/dL) or need RRT	SCr increase ≧200% or SCr ≧ 4 mg/dL or need RRT	UO < 0.3 mL/kg/h for 24 h or anuria for 12 h
RIFLE-Loss	Need RRT for >4 weeks			
RIFLE-End stage	Need RRT for >3 months			

Abbreviation: RIFLE, risk of renal failure, injury to the kidney, failure of kidney function, loss of kidney function, and end-stage renal failure; AKIN, Acute Kidney Injury Network; KDIGO, Kidney Disease Improving Global Outcome; SCr, serum creatinine; UO, urine output; GFR, glomerular filtration rate; RRT, renal replacement therapy.

Figure 1: Comparison of RIFLE, AKIN and KDIGO classification for diagnosis of AKI. Adopted from Researchgate.net.

KDIGO stages AKI into three severity grades. This is important because, with increased stage of AKI, the risk for death and need for RRT increases (Susantitaphong et al., 2013). The staging is as follows:

Table 1: AKI staging by KDIGO.

Stage	**Serum creatinine**	**Urine output**
1	1.5 to 1.9 times baseline	<0.5ml/kg/h for 6 to 12 hours
	OR	
	≥26.5µmol/l increase	
2	2.0 to 2.9 times baseline	<0.5ml/kg/h for ≥12 hours
3	3.0 times baseline	<0.3ml/kg/h for ≥24 hours
	OR	OR
	Increase in serum creatinine to ≥353.6µmol/l	Anuria for ≥12 hours
	OR	
	Initiation of renal replacement therapy	
	OR in patients <18 years, decrease in eGFR to <35ml/min per 1.73m^2	

Acute kidney injury is a potentially fatal condition that is often misdiagnosed and a global problem that occurs both in the community and in the hospitals (Cheng et al., 2017). The incidence of AKI based on data from high income countries is about 1 in 5 admissions to hospital and 1 in 4 of those that develop AKI die from its complications (Susantitaphong et al., 2013). Evidence from studies suggest that even small changes in serum creatinine are associated with increased mortality, length of stay and costs in hospitalized patients (Chertow et al., 2005).

1.2 Problem Statement

The global burden of acute kidney injury is estimated to be 13 million cases per year, 85% of which are in the low- to middle- income countries (Ponce & Balbi, 2016). It is a potentially catastrophic complication in hospitalized patients and a predictor of both immediate and long-term outcomes in patients. It can lead to development of chronic kidney disease (CKD) and in patients with preexisting CKD, it accelerates progression to end stage renal disease (ESRD) and carries a mortality risk (Coca et al., 2012). Majority of AKI in sub-Saharan Africa is community acquired hence potentially preventable and treatable. AKI is also reported to be more aggressive with worse outcomes in sub-Saharan Africa than anywhere else. This is attributable to late presentation to hospital and reliance on clinical criteria to make a diagnosis, which only become apparent at an advanced stage (Olowu et al., 2016)

Eighty five percent of the world's population live in the developing world and assumes the same incidence and outcome of AKI as the developed countries when the greatest impact of AKI could actually be in the poorest parts of the world. It is in these parts of the world, however, where data on AKI is scarce. In 2013, the International Society of Nephrology (ISN) launched the 0by25 initiative for AKI (zero preventable deaths by 2025) in response to this concern. One of its key pillars is to compile existing and prospective data on AKI's prevalence and to improve diagnostic and treatment methods, in an attempt to improve management of AKI and its consequences in order to eliminate preventable deaths from AKI worldwide by the year 2025 (Mehta et al., 2015).

1.3 Study Justification

There is paucity of data on outcomes of acute kidney injury in our set up. This study will fill that gap and add to the body of knowledge on AKI both locally and internationally in line with the 0by25 initiative. Improved knowledge on the outcomes of patients with AKI will help in decision making and assist in setting up strategies for mitigation of AKI risk and in improvement efforts. The study will help to inform policies and in planning at the relevant levels of health administration.

1.4 Research Question

What are the outcomes of patients with Acute Kidney Injury at Moi Teaching and Referral Hospital (MTRH)?

1.5 Objectives

1.5.1 Broad Objective

To describe the clinical presentation and determine the 90-day outcomes of patients with AKI as seen at MTRH.

1.5.2 Specific Objectives

1. To describe the clinical presentation of patients with AKI at MTRH.
2. To determine the severity of AKI as seen at MTRH using KDIGO criteria.
3. To determine the 90-day outcomes (need for dialysis, progression to CKD, recovery and mortality) in patients with AKI at MTRH.

CHAPTER TWO: LITERATURE REVIEW

2.1 Epidemiology

The incidence of AKI varies between definitions and populations (Hoste et al., 2006), from more than 5,000 cases per million people per year for non-dialysis-requiring acute kidney injury, to 295 cases per million people per year for dialysis requiring disease. The estimated incidence of AKI during hospitalization among all patients is 2-5% and is especially common in critically ill patients, in whom the prevalence is greater than 60% (Ali et al., 2007).

Acute kidney injury is a global problem that occurs both in the communities and in the hospitals. Community-acquired acute kidney injury (CAAKI) tends to occur in low-income countries, and in young people with few comorbidities, whereas hospital-acquired acute kidney injury occurs mostly in high-income settings, and in older people (45–80 years), often with several comorbidities (Ibrahim et al., 2016). In Africa, CAAKI is a challenging problem because of the disease burden especially HIV related AKI, malaria, nephrotoxins mainly from herbal remedies and diarrheal diseases, late presentation of patients to health facilities, lack of resources to support AKI patients and paucity of data on the epidemiology. In a world meta-analysis, the pooled incidence of AKI was 21.6% and mortality was 23.9% in adults. Only one of 154 included studies was from sub-Saharan Africa (Susantitaphong et al., 2013).

In a study done in the United States of America to determine the incidence and mortality of acute renal failure in Medicare beneficiaries from 1992 to 2001, the overall incidence rate of acute renal failure was 23.8 cases per 1,000 discharges, with rates increasing by approximately 11% per year. Older age, male gender, and black race were strongly associated with acute renal failure (Xue et al., 2006).

A multicenter study done in acute medical units of hospitals in England and Scotland identified a prevalence of AKI at 17.7%, with sepsis, hypovolemia, chronic kidney disease and diabetes mellitus identified as the major risk factors (Finlay et al., 2013).

Although there is paucity of data on the epidemiology of AKI in Africa (Naicker et al., 2008), a systematic review to assess outcomes of AKI in sub-Saharan Africa identified an overall pooled mortality of 32% in adults (Olowu et al., 2017).

In South Africa, the incidence of AKI in the population studied by Dlamini et al, was 3.4% of hospital admissions and AKI carried a high mortality risk, most significant risk factors being sepsis, late dialysis initiation and mechanical ventilation (Dlamini et al., 2017). A study done in Malawi that looked at the incidence, aetiology and outcomes of community acquired AKI in the medical admissions had an incidence of AKI of 17.2% (Evans et al., 2017) while in Cameroon a similar study found a global incidence of AKI of 22.3% (Halle et al., 2017).

Unpublished data in Kenya, from a center-based study found a period prevalence of AKI at 1,050 per 100,000 (Munyu, 2008) while a recent study that looked at the prevalence, severity and two-week outcomes of patients with community acquired Acute kidney injury in Kenyatta National Hospital found a prevalence of 8.1% at admission into the medical wards (Mohammed, 2018).

Acute kidney injury is associated with increased in-hospital and post-hospitalization resource utilization (Liangos et al., 2006). This is because more resources are required to prevent AKI and to provide renal support for those patients requiring renal replacement therapy (Naicker et al., 2008). The total expenditures attributable to hospital acquired AKI in the high-income countries is in the excess of 10 billion USD annually (Chertow et al., 2005)

2.2 Risk Factors

The onset of AKI is multifactorial, and several patient-specific factors can contribute to the risk of developing AKI. Patients with CKD, heart failure, and advanced age commonly defined as more than 65 years of age, diabetes, liver failure and dehydration are at higher risk for AKI (Kellum & Lameire, 2013). Chronic kidney disease predisposes to AKI due to overall susceptibility to illness rather than biologic susceptibility of the kidney parenchyma to injury (Singh et al., 2010). Patients with CKD are not only more likely to develop AKI and require dialysis, but also to develop end-stage renal disease with need for renal replacement therapy after an episode of AKI (Ryden et al., 2014).

In addition, specific surgery-associated factors that include time spent on cardiopulmonary bypass, the use of an intra-aortic balloon pump and need for blood transfusions are associated with AKI (Parolari et al., 2012). In order to prevent AKI, it is important to identify patients at high risk before surgery or exposure to potentially nephrotoxic agents (Borthwick & Ferguson, 2010).

2.3 Etiology

Historically, the etiology of AKI was divided into three categories: pre-renal, renal and post renal.

Pre-renal AKI occurs when plasma flow and intra-glomerular pressure are inadequate to maintain filtration capacity. The most common cause is hypovolemia, followed by a decreased cardiac output or impaired auto regulation, which may be induced by drugs such as NSAIDs. Pre-renal AKI is largely reversible in terms of normalizing baseline serum creatinine. The auto regulation of the pre- and post-glomerular

arterioles are required both for adequate renal blood flow and to maintain hydrostatic pressure in the glomeruli.

Post-renal AKI is caused by an obstruction of urinary flow. A number of causes exist such as benign prostatic hyperplasia, urethral stricture, pelvic or abdominal cancers, neurological causes as multiple sclerosis, ureter obstruction from kidney stones or ureter injury following surgery or trauma. The initial action is to exclude urinary outflow obstruction, and thereafter, ultrasound should be performed to rule out hydro-nephrosis (Endre & Pickering, 2014). In cases where flank pain is present, the preferred imaging should be computed tomography without contrast in order to rule out kidney stones.

Intra-renal AKI may be linked to nephrotoxic drugs, sepsis, renal ischemia, malignant hypertension or inflammation (e.g. glomerulonephritis, vasculitis, allergic reaction). Sepsis is associated with up to 50% of AKI, and up to 60% of patients with sepsis have AKI (Poston & Koyner, 2019). In the absence of a clear cause of AKI, inadequate response to treatment, or findings of both hematuria and proteinuria in patients with AKI, inflammatory diseases of the renal parenchyma such as glomerulonephritis and vasculitis should be suspected (Endre & Pickering, 2014).

2.4 Pathophysiology

The driving force for glomerular filtration is the pressure gradient from the glomerulus to the Bowman space. Glomerular pressure depends primarily on renal blood flow (RBF) and is controlled by the combined resistances of renal afferent and efferent arterioles. Regardless of the cause of AKI, reductions in renal blood flow represent a common pathologic pathway for decreasing glomerular filtration rate (GFR).

In pre-renal failure, GFR is depressed by compromised renal perfusion. Tubular and glomerular function remains normal. Intrinsic renal failure includes diseases of the kidney itself, affecting the glomerulus, tubules, interstitial and small vessels, which is associated with the release of renal afferent vasoconstrictors. Ischemic renal injury is the most common cause of intrinsic renal failure. Obstruction of the urinary tract initially causes an increase in tubular pressure, which decreases the filtration driving force. This pressure gradient soon equalizes, and maintenance of a depressed GFR then depends on renal efferent vasoconstriction (Harrison's Principles of Internal Medicine 19th Edition)

2.5 Diagnosis.

Glomerular filtration rate (GFR) is the best overall index of kidney function in health and disease (Stevens et al., 2009). GFR cannot be measured directly. The urinary or plasma clearance of an ideal filtration marker, such as inulin, iothalamate or iohexol, is the gold standard for the measurement of GFR. This is complex and cumbersome and not used in clinical practice. Instead, serum levels of endogenous filtration markers, such as creatinine, (which is freely filtered, has minimal tubular secretion and absorption, is simple and inexpensive to measure from random blood samples, and has relatively good accuracy) are used to estimate GFR, along with urinary measurements in some cases.

KDIGO criteria rely on the rise in serum creatinine or a decrease in urinary output to make a diagnosis of AKI. Among patients who present with AKI without a reliable baseline serum creatinine on record, it can be estimated using the Modification of Diet in Renal Disease (MDRD) Study equation assuming that baseline eGFR is 75 ml/min per 1.73 m^2 (KDIGO, 2012).

2.6 Supportive evaluation

2.6.1 Urinalysis

Urinalysis and urine microscopy are the most important noninvasive tests in the initial workup of acute kidney injury particularly intrinsic AKI. Acute tubular necrosis (ATN) will show granular, muddy brown casts on urine microscopy and may also show the presence of tubular cells or tubular cell casts.

Sepsis associated-AKI shows more renal tubule epithelial cells and cast elements compared with non-septic AKI. New albuminuria was associated with an odds ratio of 1.87 (1.21 to 2.89) for developing sepsis associated-AKI, even after adjustment for baseline GFR, severity of critical illness, and exposure to nephrotoxins. Routine dipstick albuminuria has also been shown to be independently associated with lower rates of recovery from AKI (Poston & Koyner, 2019).

2.6.2 Renal ultrasonography

While sonography can be useful in AKI, its use should be limited to those patients in whom the cause is not apparent or in whom urinary obstruction is suspected, particularly older men. Post renal AKI may be considered when the post void residual urine is greater than 100 mL and this requires renal ultrasonography to detect hydro-nephrosis or outlet obstruction. Besides ruling out urinary obstruction, sonography is useful in diagnosing unrecognized CKD. Increased echogenicity of the kidneys and size of less than 8 centimeters will be seen in CKD (O'Neill, 2014).

2.7 Treatment and prevention

Treatment of AKI is aimed at addressing the underlying causes of AKI, limiting damage and preventing progression. The key principles being: to treat the underlying disease, to optimize fluid balance and optimize hemodynamics, to treat electrolyte

disturbances and to discontinue or renal-dose nephrotoxic drugs and drugs with renal elimination (Hertzberg et al., 2017).

Provision of renal replacement therapy (RRT) in patients with AKI is extremely variable and based primarily on empiricism and local institutional practice and resources (Gibney et al., 2008). However, RRT is indicated when there is refractory hyperkalemia, refractory metabolic acidosis, refractory volume overload and uremic symptoms (Bagshaw et al., 2009).

Patients, both on admission and during their hospital stay should be assessed regularly for their risk of developing AKI. Recognition of patients at risk will allow measures to be undertaken to reduce exposure to renal insults and maximize renal recovery should AKI occur (Harty, 2014).

2.8 Outcomes

2.8.1 Recovery and progression to CKD.

Patients who survive AKI have a greater risk of CKD, ESRD, and other adverse outcomes compared to patients without AKI after adjustment for confounding variables. The risk of developing CKD among these patients was 8.8 times higher than the risk among non-AKI patients; similarly, the risk of progression to ESRD was 3.1 times higher, and the risk of mortality was 2 times higher (Coca et al., 2012).

A study by Ali et al. found that 92.5% of patients who survived AKI had full renal recovery, 7% had partial renal recovery and 0.6% had no recovery (Ali et al., 2007). Olowu et al. in their study, estimated renal recovery to be 55% in adults with 13% of the participants developing residual CKD (Olowu et al., 2017). In Cameroon, 84.2% of the patients were reported to have full renal recovery, 14.7% partial recovery and only 1.1% progressed to CKD (Halle et al., 2017) while in a study done in South Africa by Dlamini et al, 79.8% of the patients had full renal recovery, and 3.4% had end-stage renal disease at 90 days (Dlamini et al, 2017).

In Kenya, a study done by Munyu Peter in private facility had majority of the patients, 86.2% managed conservatively for their AKI episode, 49% of the patients had full recovery, 33.3% had partial recovery while 0.98% had persistent loss (Munyu, 2008)**.** Mohammed in his study at KNH reported a non-recovery rate of 60% with 18.6% patients recovering fully. He also found out that the more severe the AKI, the lesser the chances of recovery the patients had (Mohammed, 2018).

2.8.2 Mortality

In a world meta-analysis on the incidence of AKI, the pooled AKI-associated all-cause mortality rate was 23.9% in adults and increased with higher stages of severity (Susantitaphong et al., 2013), while in a systemic review in sub-Saharan Africa the pooled mortality rate of AKI in adults was 32% (Olowu et al., 2017). A study done in Cameroon had a global mortality rate of 36.9% (Halle et al., 2017) while in South Africa a similar study on the outcomes of AKI found a 90-day all-cause mortality rate of 38.8% (Dlamini et al., 2017). In Kenya, Munyu reported an in- hospital mortality of 15.68% of the patients with acute kidney injury (Munyu, 2008) and Mohammed in his study at Kenyatta National Hospital found an in-hospital all- cause mortality of 16.8% (Mohammed, 2018).

2.8.3 Need for Renal Replacement Therapy.

Renal replacement therapy (RRT) is often required and represents a substantial escalation in the complexity and cost of care for critically ill patients with AKI (Bagshaw et al., 2009). In a multi-center multinational study, Uchino et al, found that AKI occurred in 5 to 6% of all ICU admissions, with 70% of these eventually receiving RRT (Uchino et al., 2005). The pooled rate of dialysis requirement for AKI in the worldwide meta-analysis was estimated at 2.3% (Susantitaphong et al., 2013). A study in Cameroon had only 10.1% of the participants require dialysis (Halle et al.,

2017) and this was much lower than the pooled rate of dialysis requirement in sub-Saharan Africa that stood at 70%. Only 33% of the patients in sub-Saharan Africa received dialysis when indicated (Olowu et al., 2017). Among patients who survive AKI, as many as 15% require dialysis at the time of discharge (Wald et al., 2009).

2.9 Determinants of the outcomes: Mortality

Mortality is reported to be lower in countries with higher expenditure on health care, reflecting on better access to health care and dialysis in these countries. When stratified by whether dialysis, when indicated, was received or not, pooled mortality was significantly higher in adults who did not receive dialysis when indicated (86% *vs* 30%; $p < 0.0001$) (Olowu et al., 2017).

Increase in mortality correlates with the increase in severity of AKI (Thakar et al., 2009; Chawla et al., 2011; Susantitaphong et al., 2013). In addition, mortality in patients with underlying CKD has been found to be higher, possibly due to the smaller deteriorations in renal function required in order to attain a severe stage of AKI in such patients (Waikar et al., 2008).

Even when dialysis is initiated, the mortality has been shown to be high particularly with higher blood urea nitrogen (BUN). Initiation of RRT at higher BUN (more than 27.1 mmol/l]) was associated with an increased risk of death with a relative risk of 1.85. Additional contributors to poorer outcomes include older age, multiple co-morbidities (Lombardi, Yu et al. 2008), the duration of AKI irrespective of its severity (Kellum, 2015) and fluid overload before initiation of dialysis (Bouchard et al., 2009). Fluid overload is independently associated with mortality. The adjusted odds ratio for death associated with fluid overload at dialysis initiation was 2.07 (Macedo et al., 2010).

CHAPTER THREE: METHODOLOGY

3.1 Study Setting.

The study was carried out at Moi Teaching and Referral Hospital medical, surgical and gynecological wards. This is the second largest National Teaching and Referral Hospital (level 6 Public Hospital) in the country with a bed capacity of 1600 patients, an average number of 1,200 patients at any time and about 1,500 out patients per day. It serves a population of 20 million people (40% of Kenya's population) in western Kenya and is the primary care site for the 300,000-urban population of Eldoret town ("Moi Teaching and Referral Hospital (MTRH) | Devex," n.d.). MTRH acts as the nephrology referral center for the western Kenya including provision of renal replacement therapy to patients with acute kidney injury and end stage kidney disease.

3.2 Study Population

All patients above eighteen years admitted into the medical, surgical and gynecological units with acute kidney injury between January and July 2018.

3.3 Study Design

This was a prospective cohort study. Patients who developed AKI during study period were recruited and followed up for 90 days for the development of outcomes of interest.

3.4 Sample Size Determintion

The aim of the study was to determine the 90-day outcomes of the patient with AKI who get admitted to MTRH. One such expected outcome is mortality. Literature shows that the mortality rate among this population is 38.8% (Dlamini et al., 2017). In our sample size determination, we used this estimate to determine the number we require to sample from this population. Thus, in order to be 95% confident that we

report this mortality within plus or minus 5%, we determined the sample size using the following formula (Cochran, 1963);

$$n = \left(\frac{Z_{1-\alpha/2}}{d}\right)^2 \times P(1-P)$$
$$= \left(\frac{1.96}{0.05}\right)^2 \times 0.388(1-0.388)$$
$$= 365$$

Where Z_c is the quantile of the standard normal distribution which corresponds to c x 100% percentile, c = (1 – a/2), d is the margin of error, and P is the assumed incidence of death in this population. The computed sample size was 365.

However, the cases of acute kidney injury developed by patients while in the hospital is scarce and ranges between 10 and 15 per month, end points inclusive. This gives a total of 60-90 participants in 6 months.

Evidently, the population size is smaller than the calculated sample size, thus we included everyone who met the inclusion criteria in our study within a period of 6 months.

3.5 Sampling

Purposive sampling approach was used to recruit the participants who meet the inclusion criteria into the study during the 6-month study period. A purposive sampling method known as criterion sampling method was used to select the cases of acute kidney injury that met this criterion (Patton, 2001, p. 238). This was combined with the need to have reference from the in-charge clinician to an acute kidney injury case.

3.6 Eligibility Criteria

3.6.1 Inclusion criteria

1. Patients aged eighteen years and above.
2. Those admitted and have acute kidney injury meeting KDIGO 2012 criteria:
    - Increase in serum creatinine value by ≥26.5 μmol/l within 48 hours in the absence of a prior history of, or clinical features to suggest the presence of chronic kidney disease
      OR
    - A 150% (1.5-fold) increase in serum creatinine from baseline which was known or presumed to have occurred within the prior 7 days.

3.6.2 Exclusion criteria

History of kidney transplant. This is because patients with history of kidney transplant are at risk of graft rejection that can present as AKI and it's a different end point from the general population.

3.7 Study Procedure

Daily surveillance of the renal, medical, surgical and gynecological units for eligible participants for purposes of research was done. Any referrals from clinicians rotating in the same units was also taken in. Patient details were obtained from the clinicians and the patients were then located. Those who met the inclusion criteria and consented for the study, gave history as guided by a standardized interviewer administered questionnaire. A thorough clinical examination by the investigator was then done, and clinical assessment for the most likely cause of the acute kidney injury was made. This was based on history, physical examination and laboratory findings. Patients whose renal failure improved on fluid resuscitation were deemed to have had pre-renal failure. In case of doubt, nephrologist and supervisor performed final patient assessment. Thereafter, laboratory data was collected from the file and the KDIGO

staging applied. Where laboratory and radiological tests were not available because of financial constraints, the investigator catered for the costs. Routine care to the patients was provided by the hospital physicians. Investigator followed up the patients while in the hospital on alternate days until discharge for assessment of need for dialysis, duration of hospital stay, recovery and hospital mortality. Once discharged, patients were contacted at thirty days for assessment of survival, and at or after ninety days following the acute kidney injury episode, to present themselves for a repeat serum creatinine level. Patients who had abnormal serum creatinine level were referred for follow up at the Renal Unit.

3.8 Data Collection and Management

Data was collected using a structured interviewer administered questionnaire. The data captured by the questionnaire included: demographic characteristics (age, sex), risk factors (history of vomiting, diarrhea, blood loss, drug usage, contrast exposure, sepsis, obstruction, HIV status, diabetes, hypertension, CKD), hydration status at presentation, ultrasound scan findings, baseline serum creatinine, peak serum creatinine and serum creatinine at 90^{th} day post admission, urine dipstick results and urine microscopy results, KDIGO stage, need for dialysis, indication for dialysis, and days to the start of dialysis, duration of dialysis, days to complete recovery, date of death (where applicable), and duration of hospital stay.

3.9 Laboratory Methods.

The renal function tests were done in the MTRH main laboratory using a well calibrated BioLis 50i superior machine. It had been validated for precision, accuracy, sensitivity and specificity in the measurement of creatinine.

3.10 Quality Assurance

Standard operating procedures for specimen collection and transport were followed with timely delivery to the laboratory to minimize pre-analytical errors. The blood and urine specimen were then taken to the main laboratory. This laboratory undergoes both internal and external quality control measures and is International Standards Organization (ISO) certified.

3.11 Variables and Measurements

The main outcomes of measure (dependent variables) included:

1. Severity of acute kidney injury.
2. Need for renal replacement therapy.
3. Recovery.
4. Progression to chronic kidney disease.
5. Mortality.

The independent variable included:

1. Age.
2. Sex.
3. Potential precipitators for acute kidney injury.
4. Peak serum creatinine levels.
5. Underlying medical condition.

3.12 Data Analysis

The data collected was converted into electronic format by entering it into Microsoft Access database. The data converted into electronic format was stripped of identifiers and the database password protected. The password was available to the lead investigator alone. Protected backup copies were created and kept in separate places to safeguard against data loss. Once conversion was complete, the paper form

questionnaires were kept in a cabinet under lock and the key kept by the lead investigator.

Data analysis was done using software for statistical computation known as R (R Core Team, 2016). Categorical variables such as gender, hydration status, occurrence of AKI, severity of illness, need for renal replacement therapy, and death among others were summarized using frequencies and the corresponding percentages. Continuous variables such as age and serum creatinine level were assessed for Gaussian assumptions. If the assumptions held, they were summarized using mean and the corresponding standard deviation (SD). Otherwise, they were summarized using median and the corresponding inter quartile range (IQR). Gaussian assumptions were assessed using Shapiro-Wilk test and graphically using normal probability plots and histograms.

Categorical variables were explored for association with categorical outcome variables using Pearson's Chi Square test. Continuous variables were compared using independent samples t-test if the Gaussian assumptions held. Results were presented using tables and graphs.

3.13 Ethical Consideration

Approval to conduct the study was sought from Moi Teaching and Referral Hospital/ Moi University - Institutional Research and Ethics Committee (IREC). The study and study procedure were explained to those who met the eligibility criteria on first contact in the hospital, and a written consent was provided for signing. The written consent was done in English and participant were required to sign at the bottom. Those unable to write gave finger-print impression. The study participants were assured of anonymity and confidentiality by omitting names on the questionnaires,

and data was stored in a confidential and safe location. Computers used for data entry and analysis were password protected. In case of publication and presentations, only de-identified data will be shared.

CHAPTER FOUR: RESULTS

Recruitment Schema.

The study was carried out between January 2018 and July 2018 at Moi Teaching and Referral Hospital and 103 patients were recruited.

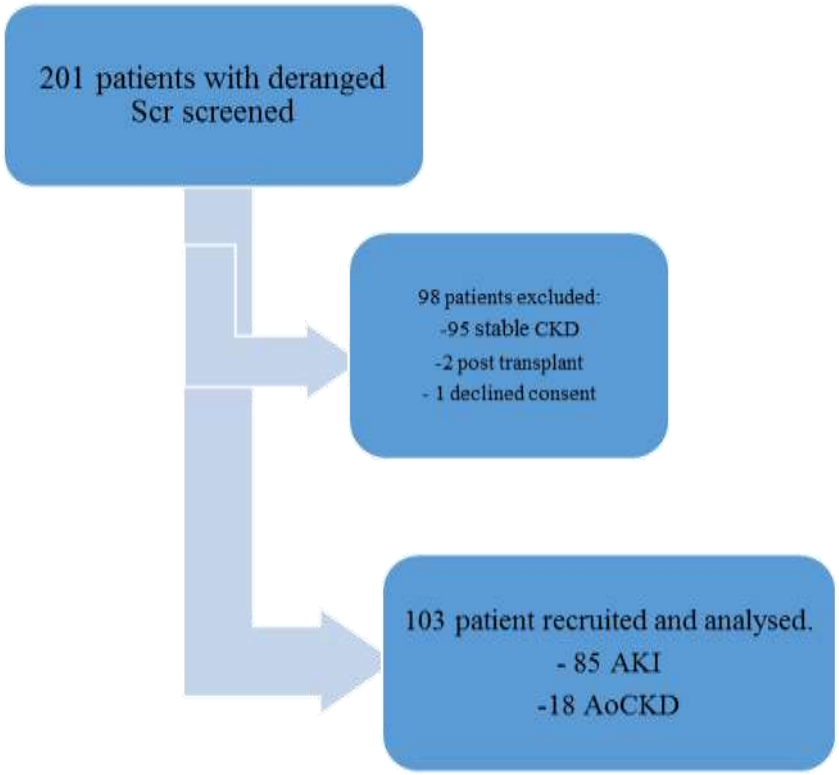

Figure 2: Recruitment schema

4.1 Baseline Characteristics.

In the study, 103 patients were analyzed 42 females and 61 males. The mean age of occurrence was 46.7 (SD 18.3) years. Majority of the patients were in the 25- 44 year age group at 38.8 per cent. Eighty-two patients were drawn from the medical ward representing about 80 per cent of the participants.

Table 2: Baseline characteristics of patients with AKI at MTRH.

	Female (n=42)	Male (n=61)	Total (n=103)
Ward of Admission			
Medical	31 (73.8%)	51 (83.6%)	82 (79.6%)
Gynecology	11 (26.2%)	0 (0%)	11 (10.7%)
Surgical	0 (0%)	10 (16.4%)	10 (9.7%)
Age category			
18-24 Years	7 (16.7%)	9 (14.8%)	16 (15.5%)
25-44 Years	22 (52.4%)	18 (29.5%)	40 (38.8%)
45-65 Years	10 (23.8%)	19 (31.1%)	29 (28.2%)
65+ Years	3 (7.1%)	15 (24.6%)	18 (17.5%)

4.2 Clinical characteristics.

The mean systolic blood pressure was 117 mmHg (SD 30.8) whereas the mean diastolic pressure was 72.6 mmHg (SD 18.6). Eighty-one per cent of the patients had underlying comorbidities.

Table 3: Clinical characteristics of patients with AKI at MTRH.

Clinical Indicator	Total n=103 (%)
Volume Status	
Euvolemia	78 (75.7)
Fluid overloaded	13 (12.6)
Volume depleted	12 (11.7)
Systolic Blood Pressure	
Mean (SD)	116.6 (30.8)
Diastolic Blood Pressure	
Mean (SD)	72.6 (18.1)
Comorbidities	n=84 (%)
Hypertension	31 (36.9)
Human immunodeficiency Virus (HIV)	28 (33.3)
Chronic Kidney Disease	18 (21.4)
Malignancy	13 (15.5)
Congestive Cardiac Failure	13 (15.5)
Diabetes Mellitus	11 (13.1)
Liver Disease	6 (7.1)
Connective Tissue Disease	3 (3.6)
Others	6 (7.1)

4.3 Laboratory findings

4.3.1 Kidney Function Test.

Table 4: Kidney function tests of patients with AKI at MTRH

	Admission	**90th day**
	Mean (SD)	**Mean (SD)**
Urea	49.18 (192.19)	15.03 (8.46)
Creatinine	817.145 (745.76)	168.977 (149.68)
K+	5.13 (1.23)	3.35 (2.17)

The mean urea at presentation was 49.18 mmol/l (SD 192.19) while at 90th day was 15.03 mmol/l (SD 8.46), with creatinine levels reported as 817.145 mmol/l (SD 745.76) at presentation with sharp decline noted at 90th day.

4.3.2 Full Hemogram Test.

Table 5: Blood count findings of patients with AKI at MTRH.

	Overall (n=103)
Hemoglobin	
Median [Min, Max]	**9.90 [4.80, 18.8]**
Total-WBC	
Median [Min, Max]	**10.4 [1.20, 97.7]**
Neutrophil%	
Median [Min, Max]	**81.1 [40.1, 95.3]**

The Hemoglobin levels were found to have a median of 9.9 (IQR 4.8, 18.8), white blood cell reporting a median of 10.4 (IQR 1.2, 97.7) while percentage neutrophil was 81.1 percent (IQR 40.1, 95.3).

4.3.3 Urinalysis

Table 6: Urine findings of patients with AKI at MTRH.

	Total (n=103)
Specific Gravity	
1. Less than 1.010	40 (38.8%)
2. SG between 1.010 – 1.020	51 (49.5%)
3. More than 1.020	12 (11.7%)
Proteinuria	51 (49.5%)
Leukocytes	43 (41.7%)
Pus cells	22 (21.4%)
Glucose	17 (16.5%)
Hematuria	14 (13.6%)
Granular casts	12 (11.7%)
Nitrites	2 (1.9%)

Majority of the patients had a normal urine specific gravity with an element of proteinuria.

4.3.4 Ultrasound Findings

Table 7: Ultrasound parameters for patients with AKI at MTRH.

Total Eligible=85	**Left Kidney**		**Right Kidney**	
	Length	**Width**	**Length**	**Width**
Mean (SD)	10.4 (1.86)	4.77 (0.970)	10.5 (1.60)	5.38 (5.72)
Median [Min, Max]	10.4 [0.00, 15.0]	4.83 [0.00, 7.10]	10.4 [7.80, 16.9]	4.70 [3.30, 57.0]

Most patients had normal kidney sizes. One patient was noted to have a solitary kidney.

4.4 Acute Kidney Injury Risk Factors

Fifty-nine per cent of the patients had AKI attributable to a pre-renal cause (61 out of 103) while 41% (43 out of 103) had intrinsic causes and 15% (16 out of 103) had post renal cause. The specific causes in each category have been listed below. The causes were not mutually exclusive and a patient could have one or more precipitators from same or different categories.

Table 8: Presumed precipitators of AKI in patients seen at MTRH.

Pre-renal

	Overall (n=103)
Vomiting	50 (48.5%)
Diarrhea	20 (19.4%)
Blood loss	12 (11.7%)
NSAID	0 (0%)

Intrinsic/Renal

	Overall (n=103)
Sepsis	31 (30.1%)
Glomerulonephritis	16 (15.5%)
Prolonged pre-renal	14 (13.6%)
Drugs	11 (10.7%)
Muscle Injury	1 (1.0%)

Post renal

	Overall (n=103)
Benign prostate hypertrophy (BPH)	8 (7.7%)
Cervical cancer	8 (7.7%)

4.5 Length of Hospital Stay

The median length of hospital stay was 9.5 days, IQR (7, 17.8) days. When the length of hospitalization is grouped by AKI staging, the distribution is as shown

Table 9: Length of hospitalization for patients admitted with AKI at MTRH

KDIGO AKI Staging	Median length of hospitalization in days
Stage One	
Median [IQR]	10 [10, 14]
Stage Two	
Median [IQR]	10 [8,, 18]
Stage Three	
Median [IQR]	11[7, 15]

Stage one and two had a median length of hospitalization of 10 days while in stage three was 11 days.

4.6 Severity of AKI at presentation

Majority (65%) of the patients presented in stage three AKI disease while about 5 per cent had stage one AKI according to KDIGO classification.

Table 10: Severity of AKI

KDIGO AKI Stage	n=103	Percentage
1	5	4.9
2	31	30.1
3	67	65

4.7 90 Day outcomes

4.7.1 In-patient Dialysis Need

There were 31 (30.1%) patients who required dialysis, with a mean time to dialysis of 3.7 days ranging from zero to eleven days. Of these patients requiring dialysis, the mean number of sessions was 3.8 ranging from one session to seven sessions while admitted in the hospital. When grouped into the KDIGO AKI stages, the need for dialysis was as follows,

Table 11: Dialysis requirement in patients with AKI at MTRH.

	Dialysis need, n=103 (%)	
AKI Stage	**Yes**	**No**
1	0	5 (100.0)
2	2 (6.3)	29 (93.7)
3	29 (43.2)	38 (56.7)

4.7.2: Recovery

A total of 55 participants were available for the recovery outcome assessment at 90 days. 13 participants were lost to follow up. The recovery outcome status was distributed as shown in the table below. Half of the participants had complete recovery (52.7 per cent) with 14.5 percent having partial recovery. About one in three of the cohort developed end stage renal disease (ESRD).

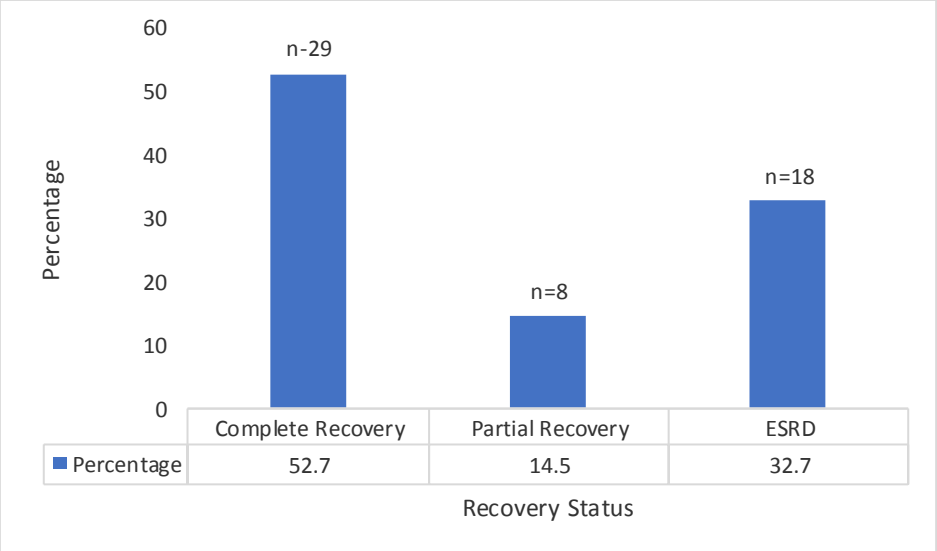

Figure 3: Recovery outcomes for patients with AKI at MTRH.

When recovery is grouped by AKI staging, all the patients in stage one and alive at 90 days had complete recovery.

Table 12: Recovery outcome by AKI stage.

	Degree of Recovery, n (%)		
Stage	**Complete Recovery**	**Partial Recovery**	**ESRD**
1	2 (100)	0	0
2	13 (65)	3 (15)	4 (20)
3	14 (42.4)	5 (15.2)	14 (42.4)

4.7.3: All-Cause Mortality

There were 35 reported deaths, representing about 34 per cent of the patients. Majority of the deaths occurred to patients with AKI KDIGO stage three, with 25 deaths in this group.

Table 13: Mortality in patients with AKI.

Severity of AKI	Mortality n (%)	
Stage	Alive	Dead
1	2 (40)	3 (60)
2	24 (77.4)	7 (22.6)
3	42 (62.7)	25 (37.3)

CHAPTER FIVE: DISCUSSION.

In this prospective study, we sought to determine the clinical presentation, the severity of AKI and the outcomes of patients with AKI admitted at Moi Teaching and Referral Hospital. The study was carried out between January and July 2018 and a total of 103 participants were studied.

5.1 Clinical presentation.

The mean age of the participants was 46.7 (SD 18.3) years. This is similar to what was reported by Dlamini et al. in a similar study done in South Africa where they had a median age of 44 years (IQR 14, 82) (Dlamini et al., 2017). Studies in developed countries report a higher mean age, for example, a study done in the USA by Chertow et al. had a mean age of 58.8 years (Chertow et al., 2005). AKI in low-income countries is usually community-acquired, occurring in young people with few comorbidities, whereas in high-income countries it's hospital-acquired and occurs mostly in older people (45–80 years), often with several comorbidities (Ibrahim et al., 2016).

There were 61(60%) males and 42(40%) females. Fouda et al. in their study on the epidemiology of acute kidney injury in a tertiary hospital in Cameroon found that 61(56.5%) were males (Fouda & Ashuntantang, 2016). Other similar studies from both developed and developing countries have found a slightly higher male preponderance (Halle et al., 2018; Wang et al., 2012). This could be a reflection of the health care access discrimination against women who lack economic and decision-making power in the developing countries, or a true increased susceptibility to renal disease in males because of possible urogenital abnormalities (Olowu et al., 2017).

Pre-renal causes accounted for the majority of AKI with hypovolemia from diarrhea and vomiting accounting for 70% of the presumed precipitating factors, while sepsis from bacterial infections accounted for 31% of cases. In Cameroon, a similar study had pre-renal AKI at 61.4% with sepsis from bacterial infections as the main precipitating factor (Halle et al., 2018). We found 11% cases of drug- induced AKI, mainly associated with amphotericin B. This was close to the reported prevalence of 18% of drug- induced AKI in sub- Saharan Africa (Olowu et al., 2017). HIV is prevalent in sub- Saharan Africa. This predisposes people living with HIV to various opportunistic infections which present with diarrhea, vomiting and inability to eat and drink well leading to volume depletion. In addition, use of nephrotoxic drugs like amphotericin B in treating HIV- related infections such as Cryptococcal infections leads to drug- induced AKI.

In our study, cervical cancer and benign prostate enlargement at 16% were implicated as causes of obstruction. A similar study by Fouda et al. that looked at the epidemiology of acute kidney injury in a tertiary hospital in Cameroon, had obstructive AKI at 11.1% (Fouda & Ashuntantang, 2016). This high proportion of cancer can be explained by the fact that our hospital is a referral center for oncology cases, and patients are usually referred to it at a late stage of the disease and with complications.

The most common comorbidities among our patients were hypertension at 36.9% and HIV at 33.3%. This finding may be due to the high prevalence of hypertension in Kenya that stands at 24.5% - 47% increasing with age (STEPS survey, 2015). Similar study in South Africa by Dlamini et al. had hypertension as the major comorbidity at 41.5% (Dlamini et al., 2017). According to World Health Organization (WHO) data, 27.4% men and 26.1% female in South Africa have hypertension. Hypertension is a

potential cause of CKD and a recognized risk factor for AKI. The proportion of patients with HIV in this study was higher than the national prevalence in the general population of 4.6% – 21% in Kenya (NACC, 2018). This is because MTRH is a referral Centre for AMPATH catchment areas. In Malawi, a similar study had HIV as the major comorbidity at 58.8% compared to their national prevalence of HIV at 10% (Evans et al., 2017). HIV increases the risk of AKI through direct renal injury, antiretroviral drugs nephrotoxicity, especially tenofovir in our setting, and susceptibility to acute infective illnesses.

5.2 Severity of AKI.

The severity of AKI was staged using KDIGO 2012 criteria. Most of our patients had severe (stage 3) disease. This was similar to a study in Malawi done by Evans et al. that looked at the incidence, etiology and outcomes of community acquired AKI in the medical admissions to a tertiary hospital, and found stage 1 disease at 21.6%, stage 2 at 17.7% and stage 3 at 60.8% (Evans et al., 2017). Our findings were also in harmony with a similar study done in Cameroon by Halle et al. that found half of their patients had AKI stage 3 (Halle et al., 2018). This is mainly due to late presentation of patients in our hospital, being a referral facility or due to limited awareness of the kidney injury related to the silent nature of the disease. However, this was different from similar studies done in the developed countries that have majority of their patients in stage one of AKI at 80% (Mehta et al., 2015). This is because most AKI in developed countries is hospital acquired, therefore picked early.

The median length of hospital stay in stage 1 and stage 2 disease was 10 days, while in stage 3 was 11 days. A study done by Ali et al. that found a median duration of stay for AKI at 17 days, and this was significantly shorter in mild forms and longer in severe AKI (Ali et al., 2007). In another study done by Chertow et al. they found that

the severity of AKI was consistently associated with an independent increase in length of hospital stay (Chertow et al., 2005).

5.3 Outcomes of AKI.

AKI is associated with adverse outcomes including mortality and high risks for development of CKD and progression to ESRD.

5.3.1 Mortality.

Globally, mortality rate from AKI is estimated to be at 23.9%, and in sub- Saharan Africa, at 32% (Susantitaphong et al., 2013; Olowu et al., 2017). In our study, the overall mortality at 90 days was 34%. This was higher than what was previously reported in a retrospective study done by Munyu, at a private facility in Kenya that used RIFLE criteria to diagnose AKI and had an overall mortality of 16.6% (Munyu, 2008). The mortality rate was however much lower than what Evans et al. in Malawi found, at 44.4% but similar to what Halle et al. in Cameroon reported, a mortality rate of 36.9% (Evans et al., 2017; Halle et al., 2018). The high mortality could be attributed to the late presentation, or the reliance of clinical criteria to make a diagnosis, which may only become apparent at an advanced stage. This high mortality is alarming given the ISN goal of zero deaths from AKI by 2025.

In this study, mortality was seen to increase with increasing severity of AKI, most deaths were observed in stage 3 at 24.3%. Similarly, Evans et al. in Malawi found that the crude mortality in patients with AKI was higher with increasing AKI severity [n = 18 (30.0%) in stage 1 and 2 vs. n = 46 (49.5%) in stage 3; p = 0.017] (Evans et al., 2017). Another study by Bagshaw et al. also showed a significant relationship between crude mortality and increasing severity of AKI (30.4% for risk, 72.7% for

injury, 90% for failure, $P < 0.001$) while using the RIFLE criteria. This underscores the importance of early detection and treatment of AKI.

5.3.2 Renal recovery.

Renal recovery could not be ascertained in 13 (12.6%) of the participants due to loss to follow-up. Majority of our patients (52.7%) had complete recovery of renal functions at 3 months, while 14.5% had partial recovery, and 32.7% progressed to ESRD. Mohammed in KNH, in a similar study had a complete recovery rate of 18.6% and partial recovery rate of 28.3% (Mohammed, 2018). This was much lower compared to our study because his recovery outcome was assessed at 2 weeks, while we assessed recovery at 3 months. The recovery rate in our study was much lower than what Halle et al., in Cameroon found (84.2%), possibly because we had a higher proportion of patients with baseline CKD (17.5% vs 6.1%) whose prognosis is worse (Halle et al., 2018). The percentage of patients with partial recovery comprises of an important group that needs long term follow up because of the risk of deterioration to ESRD.

A significant percentage of our patients progressed to ESRD. It is noteworthy that all patients with baseline CKD progressed to ESRD. This is in keeping with data that an episode of AKI accelerates progression of CKD to ESRD (Waikar et al., 2008).

5.3.3 Need for dialysis.

Thirty percent of our patients needed dialysis with a mean time to dialysis of 3.7 days (0-11 days). This was higher than the pooled dialysis requirement for AKI in the world that was estimated to be 2.3% (Susantitaphong et al., 2013). This was because most patients in the world meta-analysis had stage 1 disease, hence of good prognosis. The mortality was also much lower than the reported rate of 70% in most studies in

sub-Saharan Africa (Olowu et al., 2017), possibly because this was a prospective study, patients were screened on admission and therefore AKI was diagnosed and managed earlier, reducing need for dialysis. Dialysis was realized on all patients that needed it, possibly due to dialysis machines availability.

5.4 Study limitation:

Some of our baseline serum creatinine were based on estimations because of lack of previous known baselines, therefore, we may have diagnosed AKI in place of missed CKD.

CHAPTER SIX: CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusion:

Gastro intestinal tract losses and sepsis were the commonest risk factors for acute kidney injury with hypertension and HIV being the major comorbidities among patients with acute kidney injury. Most patients presenting at MTRH with acute kidney disease had severe disease (stage 3). Whereas majority of the patients recovered their renal functions, a significant number had partial recovery of renal functions and mortality was high.

6.2 Recommendation:

Patients with diarrhea and vomiting as well as sepsis need to be identified and managed early enough before progression to stage 3 acute kidney injury. Factors associated with late discovery of acute kidney injury need to be investigated and mitigated. Patients with partial recovery contribute to the burden of chronic kidney disease, therefore, we also recommend a long term follow up plan for this group of patients to prevent progression to end stage renal disease.

REFERENCES

Ali, T., Khan, I., Simpson, W., Prescott, G., Townend, J., Smith, W., & MacLeod, A. (2007). Incidence and outcomes in acute kidney injury: a comprehensive population-based study. *Journal of the American Society of Nephrology*, *18*(4), 1292–1298.

Bagshaw, S. M., Uchino, S., Bellomo, R., Morimatsu, H., Morgera, S., Schetz, M. … Kellum, J. A. (2009). Timing of renal replacement therapy and clinical outcomes in critically ill patients with severe acute kidney injury. *Journal of Critical Care*, *24*(1), 129–140.

Bellomo, R., Ronco, C., Kellum, J. A., Mehta, R. L., & Palevsky, P. (2004). Acute renal failure–definition, outcome measures, animal models, fluid therapy and information technology needs: the Second International Consensus Conference of the Acute Dialysis Quality Initiative (ADQI) Group. *Critical Care*, *8*(4), 1. JOUR.

Borthwick, E., & Ferguson, A. (2010). Perioperative acute kidney injury: Risk factors, recognition, management, and outcomes. *British Medical Journal (Online)*, *341*(7763), 85–91.

Bouchard, J., Soroko, S. B., Chertow, G. M., Himmelfarb, J., Ikizler, T. A., Paganini, E. P., & Mehta, R. L. (2009). Fluid accumulation, survival and recovery of kidney function in critically ill patients with acute kidney injury. *Kidney International*, *76*(4), 422–427.

Chertow, G. M., Burdick, E., Honour, M., Bonventre, J. V, & Bates, D. W. (2005). Acute kidney injury, mortality, length of stay, and costs in hospitalized patients. *Journal of the American Society of Nephrology*, *16*(11), 3365–3370.

Coca, S. G., Singanamala, S., & Parikh, C. R. (2012). Chronic kidney disease after acute kidney injury: a systematic review and meta-analysis. *Kidney International*, *81*(5), 442–448.

Cochran, W. G. (1963). *Sampling techniques. 2nd edition*. John Wiley & Sons.

Cooke, W. R., Hemmilä, U. K., Craik, A. L., Mandula, C. J., Mvula, P., Msusa, A., Evans, R. (2018). Incidence, aetiology and outcomes of obstetric-related acute kidney injury in Malawi: a prospective observational study. *British Medical journal Nephrology*, *19*(1), 25.

Dlamini, T. A. L., Heering, P. J., Chivese, T., & Rayner, B. (2017). *A prospective study of the demographics, management and outcome of patients with acute kidney injury in Cape Town, South Africa*. *145*, 1–12.

Evans, R. D. R., Hemmilä, U., Craik, A., Mtekateka, M., Hamilton, F., Kawale, Z., Dreyer, G. (2017). Incidence, aetiology and outcome of community-acquired acute kidney injury in medical admissions in Malawi. *British Medical Central Nephrology*, Vol. 18.

Finlay, S., Bray, B., Lewington, A. J., Hunter-Rowe, C. T., Banerjee, A., Atkinson, J. M., & Jones, M. C. (2013). Identification of risk factors associated with acute kidney injury in patients admitted to acute medical units. *Clinical Medicine, Journal of the Royal College of Physicians of London*, *13*(3), 233–238.

Fouda, H., & Ashuntantang, G. (2016). The Epidemiology of Acute Kidney Injury in a Tertiary Hospital in Cameroon: A 13 Months Review. *Journal of Nephrology & Therapeutics*, *6*(3), 1–6.

Gatuma, P. (UON). (1998). Hypovolemia associatedacute renal failure as seen in medical wads at Kenyatta National Hospital. *Unpublished*.

Gibney, N., Hoste, E., Burdmann, E. A., Bunchman, T., Kher, V., Viswanathan, R., Ronco, C. (2008). Timing of Initiation and Discontinuation of Renal Replacement Therapy in AKI: Unanswered Key Questions. *Clinical Journal of the American Society of Nephrology*, *3*(3), 876–880. JOUR.

Halle, M. P. E., Chipekam, N. M., Beyiha, G., Fouda, H., Coulibaly, A., Hentchoya, R., Ashuntantang, G. (2018). Incidence, characteristics and prognosis of acute kidney injury in Cameroon: a prospective study at the Douala General Hospital. *Renal Failure*, *40*(1), 30–37.

Hoste, E. A. J., Clermont, G., Kersten, A., Venkataraman, R., Angus, D. C., De Bacquer, D., & Kellum, J. A. (2006). RIFLE criteria for acute kidney injury are associated with hospital mortality in critically ill patients: a cohort analysis. *Critical Care*, *10*(3), 1. JOUR.

Ibrahim, A., Ahmed, M. M., Kedir, S., & Bekele, D. (2016). Clinical profile and outcome of patients with acute kidney injury requiring dialysis-an experience from a haemodialysis unit in a developing country. *BMC nephrology*, *17*(1), 91.

Joannidis, M., Metnitz, B., Bauer, P., Schusterschitz, N., Moreno, R., Druml, W., & Metnitz, P. G. H. (2009). Acute kidney injury in critically ill patients classified by AKIN versus RIFLE using the SAPS 3 database. *Intensive Care Medicine*, *35*(10), 1692–1702.

Lameire, N. H., Bagga, A., Cruz, D., De Maeseneer, J., Endre, Z., Kellum, J. A., … Van Biesen, W. (2013). Acute kidney injury: an increasing global concern. *The Lancet*, *382*(9887), 170–179.

Leblanc, M., Kellum, J. A., Gibney, R. T. N., Lieberthal, W., Tumlin, J., & Mehta, R. (2005). Risk factors for acute renal failure: inherent and modifiable risks. *Current Opinion in Critical Care*, *11*(6), 533–536. Journal Article, Review.

Loscalzo, D. L. A. F. D. K. S. H. J. J. J. (n.d.). *Harrison's Principles of Internal Medicine*.

Liangos, O., Wald, R., O'Bell, J. W., Price, L., Pereira, B. J., & Jaber, B. L. (2006). Epidemiology and outcomes of acute renal failure in hospitalized patients: a national survey. *Clinical Journal of the American Society of Nephrology : CJASN*, *1*(1), 43–51. Journal Article, Research Support, N.I.H., Extramural, Research Support, Non-U.S. Gov't.

Macedo, E., Bouchard, J., Soroko, S. H., Chertow, G. M., Himmelfarb, J., Ikizler, T. A., … Mehta, R. L. (2010). Fluid accumulation, recognition and staging of acute kidney injury in critically-ill patients. *Critical Care*, *14*(3), R82.

Mehta, R. L., Pascual, M. T., Soroko, S., Savage, B. R., Himmelfarb, J., Ikizler, T. A., (PICARD, P. to I. C. in A. R. D. (2004). Spectrum of acute renal failure in the intensive care unit: the PICARD experience. *Kidney International*, *66*(4), 1613–1621.

Mehta, R. L., Cerda, J., Burdmann, E. A., Tonelli, M., Garcia-Garcia, G., Jha, V., Remuzzi, G. (2015). International Society of Nephrology's 0by25 initiative for acute kidney injury (zero preventable deaths by 2025): a human rights case for nephrology. *Lancet (London, England)*, *385*(9987), 2616–2643.

Moi Teaching and Referral Hospital (MTRH) | Devex. (n.d.). Retrieved October 11, 2019,from https://www.devex.com/organizations/moi-teaching-and-referral-hospital-mtrh-41605

Mohammed, T. (UON). (2018). Prevalence, severity and outcomes of community acquired acute kidney injury in medical patients at Kenyatta National Hospital. *Kenya Association of Physicians*.

Munyu, P. (Agha Khan U. (2008). Prevalence, risk factor and outcomes of acute renal failure in Agha Khan University Hospital, Nairobi. *Unpublished*.

Naicker, S., Aboud, O., & Gharbi, M. B. (2008). Epidemiology of acute kidney injury in Africa. *Seminars in Nephrology*, *28*(4), 348–353. Journal Article.

National AIDS Control Council. (2018). Kenya HIV Estimates Report 2018. *Kenya HIV Estimates*, 1–28.

Olowu, W. A., Niang, A., Osafo, C., Ashuntantang, G., Arogundade, F. A., Porter, J., Luyckx, V. A. (2017). Outcomes of acute kidney injury in children and adults in sub-Saharan Africa: a systematic review. *The Lancet Global Health*, *4*(4), e242–e250.

Pickering, J. W., & Endre, Z. H. (2013). The definition and detection of acute kidney injury. *Journal of Renal Injury Prevention*, *3*(1), 21–215.

Ponce, D., & Balbi, A. (2016). Acute kidney injury: Risk factors and management challenges in developing countries. *International Journal of Nephrology and Renovascular Disease*, *9*, 193–200.

Poston, J. T., & Koyner, J. L. (2019). Sepsis associated acute kidney injury. *BMJ*, *364*, k4891.

Singh, P., Rifkin, D. E., & Blantz, R. C. (2010). Chronic Kidney Disease: An Inherent Risk Factor for Acute Kidney Injury? *Clinical Journal of the American Society of Nephrology*, *5*(9), 1690–1695. JOUR. https://doi.org/10.2215/CJN.00830110

Susantitaphong, P., Cruz, D. N., Cerda, J., Abulfaraj, M., Alqahtani, F., Koulouridis, I., & Jaber, B. L. (2013). World incidence of AKI: a meta-analysis. *Clinical Journal of the American Society of Nephrology*, *8*(9), 1482–1493.

Uchino, S., Bellomo, R., Goldsmith, D., Bates, S., & Ronco, C. (2006). An assessment of the RIFLE criteria for acute renal failure in hospitalized patients. *Critical Care Medicine*, *34*(7), 1913–1917.

Waikar, S. S., Liu, K. D., & Chertow, G. M. (2008). Diagnosis, epidemiology and outcomes of acute kidney injury. *Clinical Journal of the American Society of Nephrology*, *3*(3), 844–861.

Wald, R., Quinn, R. R., Luo, J., Li, P., Scales, D. C., Mamdani, M. M., Group, U. of T. A. K. I. R. (2009). Chronic dialysis and death among survivors of acute kidney injury requiring dialysis. *Jama*, *302*(11), 1179–1185.

Wang, H. E., Muntner, P., Chertow, G. M., & Warnock, D. G. (2012). Acute Kidney Injury and Mortality in Hospitalized Patients. *American Journal of Nephrology*, *35*(4), 349–355.

Were, A. J., & Otieno, L. S. (1992). Acute renal failure as seen at Kenyatta National Hospital. *East African Medical Journal*, *69*(2), 110–113. Journal Article.

Yu, L., Younes-ibrahim, M., Schor, N., & Burdmann, E. A. (2008). *Epidemiology of Acute Kidney Injury in Latin America*. *28*(4), 320–329.

Zappitelli, M., Parikh, C. R., Akcan-Arikan, A., Washburn, K. K., Moffett, B. S., & Goldstein, S. L. (2008). Ascertainment and epidemiology of acute kidney injury varies with definition interpretation. *Clinical Journal of the American Society of Nephrology*, *3*(4), 948-954.

APPENDICES

APPENDIX I: LETTER OF INFORMATION AND CONSENT FORM.

Study Title: Outcomes of Patients with Acute Kidney Injury at Moi Teaching and Referral Hospital – Eldoret.

Principal Investigator: Dr. Ngami Mutwa

Contacts: 0726206974

Before deciding to participate in this research study, it is important that you read and understand the information contained in this consent form. This form provides all the information we think you will need in order to decide whether you (or your family member) wish to participate in the research study. If you have any questions after you read through this form, ask any one of the study personnel. You should not sign this form until you are sure you understand everything on this form. You may also wish to discuss your participation in this study with your primary doctor, a family member, or a close friend.

This consent form is intended for the patient who is eligible to take part in this study. However, if the patient is incapable of providing consent due to the severity of his/her illness, the consent of a relative or other authorized representative will be sought. If the participant becomes capable of providing consent during their ICU stay, informed consent will be sought from the participant. The pronouns “you” and “your” in this letter refer to the participant.

PURPOSE OF THE RESEARCH:

You are being asked to consider taking part in this study because you have acute kidney injury. AKI is the sudden loss of your kidneys' ability to get rid of excess fluid and waste material from your blood. When your kidneys lose their filtering ability, dangerous levels of fluid and waste products, including toxins, accumulate in your body. AKI is potentially life-threatening and common in the hospitalized patients. Often, patients with AKI require dialysis temporarily, to replace the work normally carried out by the kidneys. Some patients may end up dependent on dialysis for the rest of their lives while others recover or develop chronic kidney disease.

This study seeks to determine the outcomes of patients with AKI. Your participation in this study will help the study personnel to assess those outcomes.

DESCRIPTION OF THE RESEARCH:

The study will involve collecting basic demographic (i.e. age, sex) information about you, as well as a review of your medical history including diseases/conditions that you have or have had in the past. We will collect medical information from your chart. We will be documenting laboratory results, medications, vital signs, and other data about the function of your organs**.**. After you leave the hospital, we will document your date of discharge from the hospital and as part of the follow up, we will conduct a survey with you over the telephone at 30 days for the assessment of survival and at or after 90 days following an episode of AKI to ask you to come back to the hospital for repeat laboratory works (serum creatinine) to assess the state of your kidneys.

BENEFITS

There are no direct benefits to you by participating in this study but the knowledge gained from this study will help anyone else in future with acute kidney injury in that doctors will have a better understanding of the outcomes of patients with acute kidney injury at MTRH.

HARMS.

The project in itself poses minimal risks to you since we will be collecting data from what the treating doctors have done. There might be pain and discomfort while blood is drawn from your veins.

ALTERNATIVES TO PARTICIPATION:

You do not need to participate in this study to receive treatment for your condition. In making your decision, you should bear in mind that being in the study is not a form of treatment and that being studied is not the same as being treated. If you choose not to participate, you will still receive therapy for your AKI based on the usual clinical practices.

COSTS TO PARTICIPATION and REIMBURSEMENT:

There are no costs to you should you decide to participate in this study. You will not be reimbursed nor be given money as a result of your participation**.**

PARTICIPATION AND WITHDRAWAL:

Participation in research is voluntary. You may refuse to participate, refuse to answer any questions, or withdraw from the study at any time with no effect on you or your family's future medical care. If you choose not to participate, you and your family will continue to have access to customary care at MTRH.

If you choose to withdraw from the study, the data you provided up to the point of termination (withdrawal) and information about your health status may still be used in the analysis.

CONSENT FORM.

Study Title: Outcomes of Patients with Acute Kidney Injury at Moi Teaching and Referral Hospital – Eldoret.

The research study has been explained to me, and my questions have been answered to my satisfaction. I have been informed of the alternatives to participation in this study. I have the right not to participate and the right to withdraw without affecting the quality of medical care at MTRH for me and for other members of my family. I have also been informed of the follow up period after discharge that will entail telephone survey at 30 days and at/after 90 days to present myself for assessment of kidney function. As well, the potential harms and benefits of participating in this research study have been explained to me. I have been told that I have not waived my legal rights nor released the investigators or involved institutions from their legal and professional responsibilities. I know that I may ask now, or in the future, any questions I have about the study. I have been told that records relating to me and my care will be kept confidential and that no information will be disclosed without my permission unless required by law. I have been given sufficient time to read the above information.

_____ _____ _____

Name of Participant Signature of Participant Date/Time

I have explained to the above Participant the nature and purpose, the potential benefits, and possible risks associated with participation in this research study. I have answered all questions that have been raised.

_____ _____ _____

Name of Person Obtaining Consent Signature of Person Obtaining Consent Date/Time

I am the Principal Investigator responsible for the conduct of this study at MTRH and I have delegated the explanation of this study to this participant to _____ (name of person conducting the consent discussion).

_____ _____ _____

Name of Investigator Signature of Investigator Date

Appendix II: Data collection form

Date: ……

Demographics

Date admitted: …… Medical Record Number: ……

Age: …… Sex: Male….. Female…..

Admission diagnosis: ……

History

Date of onset of symptoms: ……

Risk factors:

HIV status +ve…. -ve….. Latest CD4: ……. VL: …….

(CD4 count and VL must have been done in the last 3 months)

Known DM Yes…… No……

Known HTN Yes…… No……

Known CKD Yes…… No……

Pre-renal:

Vomiting Yes…… No……

Diarrhea Yes…… No……

Blood loss Yes…… No……

NSAID use Yes…… No…… Name: ……

Intra-renal:

Prolonged pre-renal Yes…… No……

Sepsis Yes…… No…….

Rhabdomyolysis Yes…… No…….

Drug causing ATN Yes…… No……. Name:
…….

Drug causing TIN Yes…… No……. Name:
…….

Glomerulonephritis Yes….. No…..

Preeclampsia/eclampsia Yes….. No……

Post-renal:

Obstruction Yes…… No……

Details:

……..……

..……
……..

Kidney sizes (based on ultrasound)

Right: ……. Left:
…….

(<8cms qualifies for chronic kidney disease)

Volume status (at peak creatinine or at start of RRT):

Baseline weight: …….

Peak weight: …….

Percentage overload: …….

ASSESSMENT

Most likely cause of AKI:

……
……

……
……

Presenting creatinine…….

Peak creatinine……...

At 90day creatinine……

KDIGO Staging

Baseline creatinine: ……..

KDIGO stage:

At presentation: …….

At RRT initiation: …….

RRT:

Indication: ……..

Date started: …….

Mode: …….

Number of sessions: …….

Date stopped: …….

Expected creatinine at GFR of 75mls/min/1.73m2 ……...

RECOVERY (Choose only one)

Complete recovery: Yes No Date: ……

Partial recovery: Yes No Date: ……

CKD at 90 days Yes No Date: ……6

ESRD at 90 days Yes No Date: ……

MORTALITY

Alive at 30 days? Yes No Date: ……

Alive at 90 days? Yes No Date: ……

If not, date of death: …….

Cause of death:

……
…

Appendix III: MDRD Formula

The baseline creatinine was back-calculated using the simplified modification of diet in renal disease (MDRD) formula, assuming a GFR of 75ml/min/1.73m^2 as recommended by Kidney Disease Improving Global Outcome (KDIGO).

$$epCr = \left(\frac{GFR}{Sex \times Race \times 186 \times Age^{-0.203}} \right)^{-\frac{1}{1.154}} (\text{mg/dl})$$

Where *GFR* was the assumed GFR (ml/min); *Sex* = 1 if male and 0.742 if female; *Race* = 1.21 if black, otherwise *Race* = 1; and *Age* was in years.

To convert from mg/dl to µmol/L we multiplied by 88.5

APPENDIX IV: IREC APPROVAL

INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE (IREC)

MOI TEACHING AND REFERRAL HOSPITAL
P.O. BOX 3
ELDORET
Tel: 33471//2/3

MOI UNIVERSITY
SCHOOL OF MEDICINE
P.O. BOX 4606
ELDORET

15th January, 2018

Reference: IREC/2017/140
Approval Number: 0002006

INSTITUTIONAL RESEARCH & ETHICS COMMITTEE
15 JAN 2018
APPROVED
P. O. Box 4606 - 30100 ELDORET

Dr. Ngami Mutwa,
Moi University,
School of Medicine,
P.O. Box 4606-30100,
ELDORET-KENYA.

Dear Dr. Ngami,

RE: FORMAL APPROVAL

The Institutional Research and Ethics Committee has reviewed your research proposal titled:-

"Outcomes of Patients with Acute Kidney Injury at Moi Teaching and Referral Hospital - Eldoret".

Your proposal has been granted a Formal Approval Number: ***FAN: IREC 2006*** on 15th January, 2018. You are therefore permitted to begin your investigations.

Note that this approval is for 1 year; it will thus expire on 14th January, 2019. If it is necessary to continue with this research beyond the expiry date, a request for continuation should be made in writing to IREC Secretariat two months prior to the expiry date.

You are required to submit progress report(s) regularly as dictated by your proposal. Furthermore, you must notify the Committee of any proposal change (s) or amendment (s), serious or unexpected outcomes related to the conduct of the study, or study termination for any reason. The Committee expects to receive a final report at the end of the study.

Sincerely,

DR. S. NYABERA
DEPUTY-CHAIRMAN
INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE

cc CEO - MTRH
Principal - CHS
Dean - SOP
Dean - SON
Dean - SOM
Dean - SOD

APPENDIX V: HOSPITAL APPROVAL (MTRH)

An ISO 9001:2015 Certified Hospital

MOI TEACHING AND REFERRAL HOSPITAL

Telephone:(+254)053-2033471/2/3/4
Mobile: 722-201277/0722-209795/0734-600461/0734-683361
Fax: 053-2061749
Email: ceo@mtrh.go.ke/directorsofficemtrh@gmail.com

Nandi Road
P.O. Box 3 – 30100
ELDORET, KENYA

Ref: ELD/MTRH/R&P/10/2/V.2/2010

17th January, 2018

Dr. Ngami Mutwa,
Moi University,
School of Medicine,
P.O. Box 4606-30100,
ELDORET-KENYA.

APPROVAL TO CONDUCT RESEARCH AT MTRH

Upon obtaining approval from the Institutional Research and Ethics Committee (IREC) to conduct your research proposal titled:-

"Outcomes of Patients with Acute Kidney Injury at Moi Teaching and Referral Hospital - Eldoret".

You are hereby permitted to commence your investigation at Moi Teaching and Referral Hospital.

MOI TEACHING AND REFERRAL HOSPITAL
CEO
APPROVED
17 JAN 2018
P. O. Box 3 - 30100, ELDORET

17/1/2018

DR. WILSON K. ARUASA
CHIEF EXECUTIVE OFFICER
MOI TEACHING AND REFERRAL HOSPITAL

cc - DCEO, (CS)
- Director of Nursing Services (DNS)
- HOD, HRISM